A colourful addition to the spider fauna of Victoria: the peacock spider *Maratus splendens* (Rainbow, 1896) (Araneae: Salticidae)

David De Angelis [1,2], Hayley Davis[3], Bradley Jenner[4] and Jordan de Jong[5]

[1]Applied Botany, Zoology and Ecological Consulting, Suite 1, 4 Brisbane Street, Eltham, Victoria 3095
Corresponding author email: daviddeangelis@abzeco.com.au
[2]La Trobe Wildlife Sanctuary, La Trobe University, Bundoora, Victoria 3086
[3]School of Life and Environmental Sciences, Deakin University, Burwood, Victoria 3125
[4] 5 Early Place, Boronia, Victoria 3155
[5]Department of Sciences, Museum Victoria, Melbourne, Victoria 3001

Abstract
Jumping spiders belonging to the endemic Australian genus *Maratus* are popularly referred to as peacock spiders, so called for the remarkable courtship displays of the often brightly coloured males. Several *Maratus splendens* were found in Buldah State Forest, East Gippsland in 2011 and 2013, representing the first records of this species from Victoria. Until recently, this species was known only from around Sydney. While a degree of caution should be exercised whenever implying possible new distributional records based on single localities, it is considered most likely that this discovery represents a genuine expansion in the known range of *Maratus splendens*. Details are also provided for a previously unpublished record from the central coast of New South Wales. (*The Victorian Naturalist* 130 (6) 2013, 224–231)

Keywords: *Maratus splendens*, peacock spider, first records, East Gippsland

Introduction

Maratus splendens is a relatively small (males to 4 mm long) (Otto and Hill 2011) member of a genus of jumping spiders (Salticidae) believed to be endemic to Australia where it has undergone considerable speciation (Patoleta and Żabka 1999; Richardson *et al.* 2006). The genus *Maratus* currently comprises 21 described species, all of which are sexually dimorphic, and the trait that defines the genus is the possession by males of a dorsal opisthosomal (abdominal) plate of varying ornateness (Otto and Hill 2012a). This plate is characteristically displayed by elevating the opisthosoma during often elaborate courtship and sometimes agonistic behaviours (Girard *et al.* 2011; Otto and Hill 2012a, b). In most species (including *M. splendens*), this plate bears a pair of flexible lateral flaps that are unfurled during displays. A prominent aspect of *Maratus*' signalling rituals has been coined the 'fan dance', resembling that of male peacocks. Accordingly, species within this genus are often referred to as peacock spiders (Waldock 1993; Hill 2009).

Another major attribute of the males of many *Maratus* species is the possession of relatively elongated and ornamented third legs that terminate with a section of vibrant white tarsal setae (Otto and Hill 2011, 2012a, c), one or both of which are utilised as part of signalling strategies (Hill 2009). Both leg signalling and the fan dance are typical of courtship displays by male *Maratus splendens*. A detailed description of *M. splendens* courtship repertoire is provided by Hill and Otto (2011).

The presence in male *M. splendens* of a slightly curved transverse band of dark, iridescent scales on the cephalothorax between the postero-lateral eyes (Fig. 1) is the primary characteristic used to readily distinguish males of this species from those of the closely related and morphologically similar *M. pavonis* (Hill and Otto 2011). The iridescence of this band is highly directional, with reflectance ranging from steel blue to black. In addition to this, the band is situated within a scarlet scale-field, which occupies and extends just beyond the ocular quadrangle where it abuts a small, white postero-dorsal scale patch (Hill and Otto 2011).

Until recently, *M. splendens* was known only from the Sydney region; however, the type locality provided by Rainbow (1896) was subsequently identified as being in Lane Cove National Park (Hill and Otto 2011) and the Ku-

Fig. 1. Male *Maratus splendens* found at the Tennyson Camping Area in January 2011, showing characteristic transverse band of dark iridescent scales between the postero-lateral eyes (arrow). Photo by Jordan de Jong.

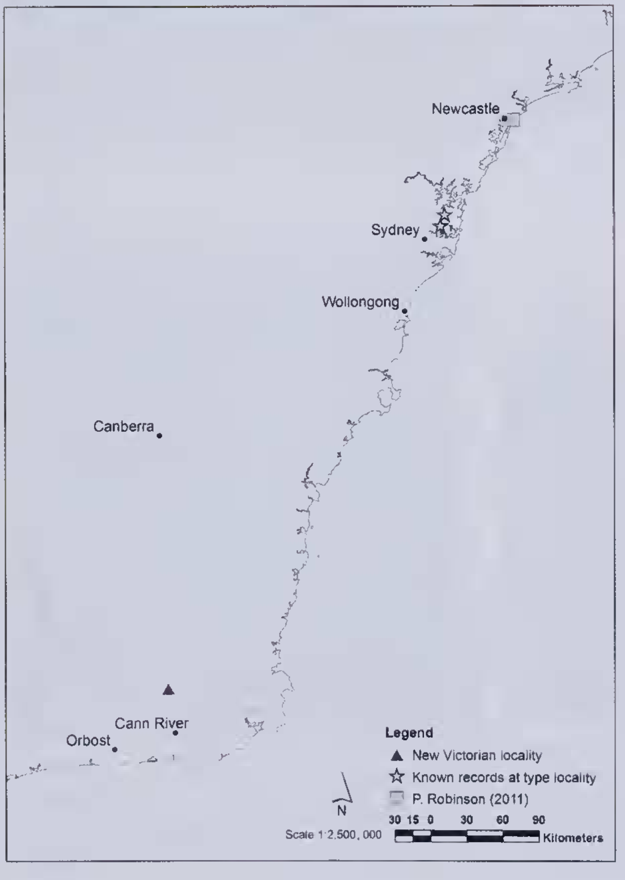

Fig. 2. Known distribution of *Maratus splendens* in eastern Australia including the new Victorian records, those from near the type locality (Sydney) and a previously unpublished record from the central coast of New South Wales.

ring-gai Wildflower Garden, St Ives (Otto and Hill 2011) (Fig. 2).

This report documents the incidental discovery of *M. splendens* in Buldah State Forest while undertaking surveys for frogs in the wider Cann Valley, East Gippsland, in January 2011, and the results of further searches undertaken there in January 2013. Possible reasons for the species' occurrence at the site and the lack of previous records from Victoria are discussed.

Observations

A single male *M. splendens* was recorded on 7 January 2011 at the Tennyson Camping Area in Buldah State Forest (37°14'32.9" S, 149°7'1.5" E), approximately 35 km north of the Cann River township (Fig. 2). The campground is located within a montane, deeply dissected valley and ridge landscape among extensive indigenous vegetation.

Additional individuals were detected upon three of the authors returning to the site to further verify the record in January 2013 (Table 1), along with a single male *M. pavonis*. These were located by actively searching on the ground and among vegetation for 2 to 4 hours (between 1100 and 1700 hrs) on each occasion, close to where the original spider was found. A diesel car engine was also left running for ten minutes over leaf litter at the site, enabling the collection of spiders that emerged in response to the vibrations (D Hirst cited in Shield 2001; Raven and Stumkat 2003).

Several individuals were photographed and, where possible, females distinguished from similarly coloured (brown) immature males by their larger size and lack of enlarged palpal tarsi. Brown individuals observed being courted by mature males were also assumed to be females given that displays have not been documented between male *M. splendens* when in close proximity to each other (Otto and Hill 2012b).

All individuals were found at the edge of an artificial forest clearing (approx. 1200 m^2) on a headwater fluvial terrace associated with Tennyson Creek. Tall, sclerophyllous vegetation surrounded the clearing, comprising floristic communities corresponding to Damp and Riparian Forest Ecological Vegetation Classes (identified using descriptions by Davies *et al.* 2002). The canopy was dominated by Manna Gum *Eucalyptus viminalis* and Gippsland Peppermint *E. croajingolensis* (B Jenner unpubl. data 2012). Additional characteristics included a tall, open secondary tree stratum of Blackwood *Acacia melanoxylon* above a patchy understorey of shrubs, ferns, grasses, herbs and bryophytes. Even though the adjacent vegetation was relatively dense, site attributes were consistent with the claim by Richardson *et al.* (2006) that *Maratus* species typically occur in areas with relatively sparse vegetation cover. The site also largely lacked understorey vegetation and was dominated by indigenous leaf litter, interspersed with small herbs and grasses. This corresponds to the description by Hill (2009) and Otto and Hill (2012a, c) of *Maratus* as inhabitants of areas supporting ground litter/woody debris and low shrubs. Most individuals were found on accumulated leaf litter, twigs, ground vegetation and strips of bark within 100 to 200 mm of logs that had been placed around the edge of the camping area (Fig. 3).

Table 1. Approximate numbers of *Maratus splendens* detected at the Tennyson Camping Area in 2011 and 2013.

Date	Number of individuals detected	
	Males	Females
7 January 2011	1	0
16 January 2013	10	1
23 January 2013	6	4

Figures front cover, 4 and 5 respectively show male and female *M. splendens* found at the camping area in 2011 and 2013. One male and two females were collected on 23 January 2013 for submission to Museum Victoria (specimen numbers MVK11746 and MVK11748-49 respectively).

Discussion

The discovery of *Maratus splendens* in East Gippsland represents the most southerly documented record for this species, which despite having been described over a century ago (Rainbow 1896), was known only from the Sydney region until recently (Hill and Otto 2011; Otto and Hill 2011). The Sydney records are the closest known to the location at Tennyson Creek, being approximately 420 km further north-east.

Fig. 3. Location where the majority of *Maratus splendens* were detected at the Tennyson Camping Area, 23 January 2013.

Fig. 4. Displaying male *Maratus splendens* observed at the Tennyson Camping Area in January 2013. Photo by Hayley Davis.

Fig. 5. Female *Maratus splendens* found at the Tennyson Camping Area in January 2013. Photo by Hayley Davis.

Although the possibility of the species having been inadvertently introduced to the campground cannot be ruled out, it is considered more likely that it is indigenous to the site given the number of individuals found, remoteness of the area, relative difficulty of access and distance from human habitation. The likelihood of an introduction is further reduced by the apparent irregular and infrequent amount of visitation to Tennyson campground, generally being accessible only by four-wheel-drive vehicle in dry weather (DSE 2008). Apart from a single land management contractor, no other persons were observed passing through the campground during the four days of fieldwork there in 2011, despite it being during a summer holiday period when the two-wheel-drive-accessible Ada River campground (approximately 3 km south of Errinundra) was near capacity. Similarly, only one passing visitor and two DSE maintenance vehicles were seen at the campground over four days in January 2013 (H Davis, D De Angelis and B Jenner pers. obs.).

Modified features at the site including the open vegetation structure maintained by slashing and placement of perimeter logs around the edge of the clearing may have influenced the microhabitat suitability for salticids. Factors associated with such characteristics (e.g. litter accumulation) have been found to support higher spider abundances (Castro and Wise 2010; Varady-Szabo and Buddle 2006), possibly due to increased prey abundances and by providing sites for nest placement (Hoefler and Jakob 2006; Richman and Jackson 1992). For salticids, these features may also provide extra vantage points and open areas where their acute vision (Blest *et al.* 1981; Land 1969a, b) could be better employed to facilitate activities such as hunting (Forster 1982; Hill 2010; Tarsitano 2006) and signalling (H Davis pers. obs.).

Maratus splendens has been detected at two other locations distant from the type locality since 2011; the first specimen being photographed at Bennetts Green in Newcastle, NSW (P Robinson unpubl. data 2011) (Fig. 2), and the second at Mt. Cooke in Western Australia (Otto and Hill 2012a). Given the distance between localities and range of habitats in which this species has so far been found, it is evident that it has a much wider distribution than had originally been reported.

There are several possible reasons as to why *M. splendens* has not been recorded within Victoria previously. Firstly, the species may be a relatively recent arrival as a result of being transported by sufficiently powerful weather systems. Spiders are reported to be efficient passive aerial dispersers using a method termed 'ballooning' (Entling *et al.* 2010), whereby silk filaments are released to create a frictional drag in updrafts to enable buoyancy (Humphrey 1987). While there are reports of ballooning dispersal in salticids (see Horner 1974 and Greenstone *et al.* 1987), it is generally recognised that litter-dwelling jumping spiders are mediocre dispersers with limited ballooning capability (Patoleta and Żabka 1999; Richardson *et al.* 2006). However, high levels of habitat disturbance have been shown to lead to increased levels of ballooning (Entling *et al.* 2010), and associated landscape altering practices such as farming and forestry may have facilitated *M. splendens*' dispersal throughout southern Australia.

Several studies have found rainfall to be a major factor influencing spider abundance, with corresponding increases in population abundances following periods of particularly high rainfall (Spiller and Schoener 1995; Shochat *et al.* 2004; Langlands *et al.* 2006). Such weather conditions typically increase vegetative growth and invertebrate prey abundances which can in turn increase spider survivorship, especially at times when individuals are usually vulnerable or exposed (i.e. during courtship or dispersal) (Spiller and Schoener 1995; Polis *et al.* 1998; Langlands *et al.* 2006). Eastern Australia experienced an atypically strong La Niña period from 2010 to 2012, in which 2010 was notably the third wettest year in recorded Australian history (BoM 2012). These recent Victorian records of *M. splendens* may therefore be the outcome of a proliferation response from an otherwise undetected population to the potentially favourable climatic conditions experienced across much of its range. While this provides a possible explanation for the recent observations, interestingly, several *Maratus* species in the vicinity of Sydney were observed in lower abundances during the 2010-2012 La

Niña event compared to the prior drought period, possibly as a result of the wetter conditions (J Otto 2013, pers. comm.).

Richardson *et al.* (2006) report that the estimated bioclimatic envelope of *Maratus* generally follows a Bassian distribution, and species have been recorded from the east, south-east and south-west of the continent. Their bioclimatic evaluation potentially provides insight into the circumstances surrounding the recent *M. splendens* record from Western Australia (Otto and Hill 2012a) as well as those from Victoria, with both occurring inside their predicted distribution. Given the bioclimatic envelope includes suitable environmental parameters for *M. splendens*, it seems highly likely that this species has been present, yet remained unnoticed in areas throughout this modelled distribution. Accurate bioclimatic modeling is dependent on the existence of comprehensive distributional records, as well as the ability to relate these to various environmental factors (Peterson and Lieberman 2012). However, a general lack of knowledge and insufficient survey effort concerning invertebrates is prevalent (New *et al.* 2012), even though they are a dominant feature of global species diversity (Langlands *et al.* 2006). In addition, Richardson *et al.* (2006) warn of the potentially biased nature of the data used for their models, reporting that the majority of studies have focused on relatively mesic ecosystems. This implies that *Maratus* could extend beyond what these models suggest (e.g. encompassing more arid landscapes); a possibility which has been supported by the recent discovery and inclusion of taxa in the genus with distributions that extend into arid and/or tropical areas such as *M. chrysomelas* (Waldock 2002; J. Otto 2013, pers. comm.), and one which should be considered if seeking to establish more accurate taxa distribution boundaries.

The Victorian records may also be the result of a pole-wards range shift in response to climate change; however, due to the deficiency of records elsewhere and the lack of more in-depth ecological studies concerning this species, it is impossible to determine if such a shift is likely to be occurring (Hickling *et al.* 2006).

Finally, the small size and associated inconspicuousness of *M. splendens* is likely to have contributed to the scarcity of records away from the type locality. It also shares a number of similar external features with the more common *M. pavonis*, and it is therefore plausible that some historical Victorian *M. pavonis* records may have actually been misidentified *M. splendens*. Indeed, there has been much confusion historically concerning museum records of these two species, with specimens catalogued as *M. splendens* later re-identified as *M. pavonis* (Hill and Otto 2011).

The *Maratus* genus shows a substantial amount of interspecific morphological diversity, especially with respect to opisthosomal ornamentation (Otto and Hill 2011, 2012b, c). It is becoming increasingly apparent that there are extant species ecotypes, such as two recently described for *M. pavonis* and another for *M. plumosus* species (sp. B) (Otto and Hill 2012a,c; 2013). This variation has the potential to further confound accurate identification, and without specimens or photographs to confirm or refute records, there is no way of knowing if misidentifications have occurred.

The mesic regions of Australia reported to be occupied by *Maratus* (Richardson *et al.* 2006) may be susceptible to the negative impacts caused by long or frequent droughts, and climatic modelling predicts that the frequency of future El Niño drought events will continue increasing, coinciding with the current trends in greenhouse gas emissions (Timmermann *et al.* 1999; Nicholls 2004, 2012). Richardson *et al.* (2006) used bioclimatic modeling to estimate *Maratus* distribution, providing a useful tool in predicting the effects that climate change may have on the genus. Similarly, Beaumont and Hughes (2002) used bioclimatic modeling to study the effects that climate change may have on the distributions of butterflies (Lepidoptera). They found that even taxa with relatively large bioclimatic envelopes (comparable to *Maratus*) have the potential to be adversely affected by climate change, with resultant influences on habitat suitability leading to range contractions and habitat fragmentation (Beaumont and Hughes 2002). A change in habitat suitability due to climate change may impact survivorship of *M. splendens* indirectly (Thomas 2010) by causing fluctuations in ecosystem productivity, with subsequent alterations to prey abundances.

Without further appraisal of distributional information, habitat parameters or population dynamics, however, it is difficult to identify how climate change or other potentially threatening processes are likely to impact species such as *M. splendens* for which such quantitative information is lacking (New *et al.* 2012).

Much remains to be discovered about the diversity, distribution and ecology of *Maratus* in general. This is highlighted by the known existence of at least 20 species (Waldock 2007), though only eight had been described prior to the recent elevation of the genus to include a number of species previously assigned to *Saitis* and *Lycidas* (Otto and Hill 2012a). Given the relatively inconspicuous nature of *Maratus splendens* and sporadic distribution of the current known records, it is considered most likely that it has previously been overlooked in Victoria, and that further surveys may reveal additional records of this and other species of *Maratus* in East Gippsland and possibly other parts of the state.

Acknowledgements

The authors would particularly like to thank David E Hill and Jürgen Otto for confirming our initial identification, reviewing an earlier draft of the manuscript and supporting its publication. Two anonymous referees provided additional constructive comments and suggestions. Thanks to Greg James for providing initial assistance with mapping and Kathy Himbeck for producing the final distribution map. Graham Milledge, Jürgen Otto, Peter Robinson and Colin Silvey provided details of *Maratus* specimens from NSW.

References

Beaumont LJ and Hughes L (2002) Potential changes in the distributions of latitudinally restricted Australian butterfly species in response to climate change. *Global Change Biology* **8**, 954–971.

Blest AD, Hardie RC, McIntyre P and Williams DS (1981) The spectral sensitivities of identified receptors and the function of retinal tiering in the principal eyes of a jumping spider. *Journal of Comparative Physiology* **145**, 227–239.

BoM (2012) *Record-breaking La Niña events: An analysis of the La Niña life cycle and the impacts and significance of the 2010-11 and 2011-12 La Niña events in Australia.* (Bureau of Meteorology: Melbourne)

Castro A and Wise DH (2010) Influence of fallen coarse woody debris on the diversity and community structure of forest-floor spiders (Arachnida: Araneae). *Forest Ecology and Management* **260**, 2088–2101.

Davies JB, Oates AM and Trumbull-Ward AV (2002) Ecological Vegetation Class mapping at 1:25 000 in Gippsland: final report. (Department of Natural Resources and Environment: East Melbourne)

DSE (2008) Tennyson Picnic and Camping Area. Forests Notes Series No FS0079 (Department of Sustainability and Environment: Cann River, Victoria).

Entling MH, Stämpfli K and Ovaskainen O (2010) Increased propensity for aerial dispersal in disturbed habitats due to intraspecific variation and species turnover. *Oikos* **120**, 1099–1109.

Forster LM (1982) Vision and prey-catching strategies in jumping spiders. *American Scientist* **70**, 165–175.

Girard MB, Kasumovic MM and Elias DO (2011) Multi-Modal Courtship in the Peacock Spider, *Maratus volans* (O.P.-Cambridge, 1874). *PloS ONE* **6**, e25390. DOI.10.1371/journal.pone.0025390 (on line 1 December 2012)

Greenstone MH, Morgan CE, Hultsch A, Farrow RA and Dowse JE (1987) Ballooning spiders in Missouri, USA, and New South Wales, Australia: Family and mass distributions. *Journal of Arachnology* **51**, 163–170.

Hickling R, Roy DB, Hill JK, Fox R and Thomas CD (2006) The distributions of a wide range of taxonomic groups are expanding polewards. *Global Change Biology* **12**, 450–455.

Hill DE (2009) Euophryine jumping spiders that extend their third legs during courtship (Araneae: Salticidae: Euophryinae: *Maratus, Saitis*). *Peckhamia* **74.1**, 1–27.

Hill DE (2010) Targeted jumps by salticid spiders (Araneae: Salticidae: *Phidippus*). *Peckhamia* **84**, 1–35.

Hill DE and Otto JC (2011) Visual display by male *Maratus pavonis* (Dunn 1947) and *Maratus splendens* (Rainbow 1896) (Araneae: Salticidae: Euophryinae). *Peckhamia* **89.1**, 1–41.

Hoefler CD and Jakob EM (2006) Jumping spiders in space: movement patterns, nest site fidelity and the use of beacons. *Animal Behaviour* **71**, 109–116.

Horner NV (1974) Annual aerial dispersal of jumping spiders in Oklahoma (Araneae, Salticidae). *Journal of Arachnology* **2**, 101–105.

Humphrey JAC (1987) Fluid mechanic constraints on spider ballooning. *Oecologia* **73**, 469–477.

Land MF (1969a) Structure of retinae of the principal eyes of jumping spiders (Salticidae: Dendryphantinae) in relation to visual optics. *Journal of Experimental Biology* **51**, 443–470.

Land MF (1969b) Movements of the retinae of jumping spiders (Salticidae: Dendryphantinae) in response to visual stimuli. *Journal of Experimental Biology* **51**, 471–493.

Langlands PR, Brennan KEC and Pearson DJ (2006) Spiders, spinifex, rainfall and fire: Long-term changes in an arid spider assemblage. *Journal of Arid Environments* **67**, 36–59.

New TR, Van Praagh BD and Yen AL (2012) Invertebrate conservation status and the limits of reliable information: examples from Victoria, Australia. *The Victorian Naturalist* **129**, 68–76.

Nicholls N (2004) The changing nature of Australian droughts. *Climatic Change* **63**, 323–336.

Nicholls N (2012) Is Australia's continued warming caused by drought? *Australian Meteorological and Oceanographic Journal* **62**, 93–96.

Otto JC and Hill DE (2011) An illustrated review of the known peacock spiders of the genus *Maratus* from Australia, with description of a new species. *Peckhamia* **96.1**, 1–27.

Otto JC and Hill DE (2012a) Notes on *Maratus* (Karsch 1878) and related jumping spiders from Australia, with five new species (Araneae: Salticidae: Euophryinae). *Peckhamia* **103.1**, 1–81.

Otto JC and Hill DE (2012b) Contests between male *Maratus vespertilio* (Simon 1901) (Araneae: Salticidae). *Peckhamia* **98**, 1–17.

Otto JC and Hill DE (2012c) Two new Australian peacock spiders that display inflated and extended spinnerets (Araneae: Salticidae: Euophryinae: *Maratus* Karsch 1878). *Peckhamia* **104**, 1–28.

Otto JC and Hill DE (2013) Three new Australian peacock spiders (Araneae: Salticidae: *Maratus*). *Peckhamia* **104**, 1–28.

Patoleta B and Żabka M (1999) Salticidae (Arachnida, Araneae) of islands off Australia. *Journal of Arachnology* **27**, 229–235.

Peterson AT and Lieberman BS (2012) Species' geographic distributions through time: playing catch-up with changing climates. *Evolution: Education and Outreach* **5**, 569–581.

Polis GA, Hurd SD, Jackson CT and Sanchez-Piñero F (1998) Multifactor population limitation: variable spatial and temporal control of spiders on Gulf of California islands. *Ecology* **79**, 490–502.

Rainbow WJ (1896) Descriptions of some new Araneidae of New South Wales. No. 7. *Proceedings of the Linnean Society of New South Wales* **21**, 628–633.

Raven RJ and Stumkat K (2003) Problem solving in the spider families Miturgidae, Ctenidae and Psechridae (Araneae) in Australia and New Zealand. *Journal of Arachnology* **31**, 105–121.

Richardson BJ, Żabka M, Gray MR and Milledge G (2006) Distributional patterns of jumping spiders (Araneae: Salticidae) in Australia. *Journal of Biogeography* **33**, 707–719.

Richman D and Jackson RR (1992) A review of the ethology of jumping spiders (Araneae, Salticidae). *Bulletin of the British Arachnological Society* **9**, 33–37.

Shield J (2001) *Spiders of Bendigo and Victoria's box-ironbark country*. (Bendigo Field Naturalists' Club: Bendigo, Victoria).

Shochat E, Stefanov WL, Whitehouse MEA and Faeth SH (2004) Urbanization and spider diversity: Influences of human modification of habitat structure and productivity. *Ecological Applications* **14**, 268–280.

Spiller DA and Schoener TW (1995) Long-term variation in the effect of lizards on spider density is linked to rainfall. *Oceologia* **103**, 133–139.

Tarsitano MS (2006) Route selection by a jumping spider (*Portia labiata*) during the locomotory phase of a detour. *Animal Behaviour* **72**, 1437–1442.

Thomas CD (2010) Climate, climate change and range boundaries. *Diversity and Distributions* **16**, 488–495.

Timmermann A, Oberhuber J, Bacher A, Esch M, Latif M and Roeckner E (1999) Increased El Niño frequency in a climate model forced by future greenhouse warming. *Nature* **398**, 694–697.

Varady-Szabo H and Buddle CM (2006) On the relationships between ground-dwelling spider (Araneae) assemblages and dead wood in a northern sugar maple forest. *Biodiversity and Conservation* **15**, 4119–4141.

Waldock JM (1993) Peacocks of the spider world. *Australian Natural History* **24**, 10–11.

Waldock JM (2002) Redescription of *Lycidas chrysomelas* (Simon) (Araneae: Salticidae). *Records of the Western Australian Museum* **21**, 227–234.

Waldock JM (2007) *What's in a name? Or: why* Maratus volans *(Salticidae) cannot fly*. Poster presented at the 17th International Congress of Arachnology, São Paulo, Brazil (Western Australian Museum: Perth)

Received 14 March 2013; accepted 25 July 2013

Maratus splendens displaying, Sydney region. Photo by Jürgen Otto.